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PROCEEDINGS
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ROYAL SOCIETY OF EDINBURGH.

VOL. II. 1844–5. No. 25.

SIXTY-SECOND SESSION.

Monday, 2d December 1844.

SIR T. M. BRISBANE, Bart., President, in the Chair.

The following Communications were read:—

1. Account of the late Earthquake at Demerara. By W. H. Campbell, Esq. Communicated by M. Ponton, Esq.

2. On the Existence of an Electrical Apparatus in the Flapper Skate and other Rays. By James Stark, M.D., Fellow of the Royal College of Physicians, Edinburgh.

The author, after noticing the fishes in which an electrical apparatus had been discovered, stated that, with the exception of Geoffroy St Hilaire, no writer had endeavoured to shew that Skates possessed electrical organs. The organ to which that writer alluded, the author regarded as nothing else than muciparous ducts, identical with the very same organs in the Torpedo, and quite distinct from the electrical organs. The circumstance was then mentioned which directed the author's attention to the tail of the skate, and led him to suppose that an electrical organ might exist in it.

On removing the skin from the tail of a Flapper Skate, an organ was discovered occupying the place of the lateral muscles, extending from near the base to the very tip of the tail, and possessing all the anatomical characters of the electrical apparatus of fishes. It was about 14 inches in length, and about half an inch in diameter for nearly one-half of its length; was composed of columns or four-sided membranous tubes, about the twelfth of an inch in diameter, divided by cross membranous septa into compartments varying from the twentieth to the thirtieth of an inch in diameter. These compartments were filled with a transparent gelatinous matter. The columns were so arranged as to form layers, which, on a transverse section, were seen to have a concentric arrangement, but on a longitudinal section, were seen to form hollow cones placed one within the other. This arrangement allowed about three-fourths of the wide extremity of every cone-shaped layer to come in contact with the skin.

The microscope shewed the walls of the columns and their cross septa to be composed of dense fibrous and filamentous tissue, on which the blood-vessels and nerves were minutely ramified. The gelatinous matter which filled the compartments was seen to be composed of very minute cells, the walls of which were composed of a fine transparent membrane, over which the nerves were seen to ramify in the most beautiful manner. The interior of these very minute transparent cells was filled with a transparent jelly.

A rough chemical examination shewed the organ to be composed principally of gelatine, and in small part of albumen. No fibrin was observed in it.

The organ was supplied with nerves from three sources, viz., from the lateral branch of the eighth pair, and from the anterior and posterior caudo-spinal nerves.

This organ did not exist in equal development in every species of Ray. In most of them it was merely rudimentary, not being thicker than a crow-quill or common pen, and consisted of only four or five columns, similarly divided into cells by cross membranous septa.

The author formed the conclusion that this was an electrical apparatus from the following purely anatomical considerations, as he had not an opportunity of ascertaining the occurrence of electrical discharges from the organ by an examination of living specimens.

1. The structure of the organ was the same as that of the electrical apparatus of the Torpedo and Electrical Eel—consisting of membranous tubes or columns arranged in layers, each column being divided into distinct compartments filled with a gelatinous fluid.

2. All the layers of tubes communicated with the skin, and that skin was abundantly supplied with mucus.

3. The organ was supplied not only with spinal nerves, but with the descending branch of the eighth pair, which, along with a branch of the fifth pair, is the electrical nerve of the allied genus Torpedo;

whereas, in other fishes, this nerve is solely distributed to the insignificant muscles which move the fin of the tail.

4. The microscopic structure is the same as that of the electrical organs of the Torpedo and Electrical Eel.

5. The chemical constitution is the same as that of the electrical organs of the Torpedo, consisting of gelatine and albumen, but no fibrin.

The paper was concluded with a few remarks on the probable uses to the Rays of an electrical organ; and by directing the attention of naturalists to the probable existence of electrical organs in many soft-bodied fresh and salt water animals, as Polypi, Asterias, &c.

3. Observations on the Comet, visible now or lately in the Constellation of the Whale. By C. Rumker, Esq. Communicated by Sir T. M. Brisbane, Bart.

The following Donations were announced:—

Transactions of the American Philosophical Society, held at Philadelphia, for promoting Useful Knowledge. Vol. ix., Part 1. —*By the Society,*

Bulletin de la Société Geologique de France. Tome xiii.—*By the Society.*

Memoirs and Proceedings of the Chemical Society. Parts 7, 8, 9. —*By the Society.*

Journal of the Statistical Society of London. Vol. vii., Parts 1, 2, 3.—*By the Society.*

Journal of the Asiatic Society of Bengal, 1843. No. 142.—*By the Society.*

Det Kongelige Danske Vindenskabernes Selskabs Naturvidenskabelige og Mathematiske Afhandlingar. Deels ix. and x.—*By the Society.*

A System of Mineralogy, comprising the most Recent Discoveries. By James D. Dana.—*By the Author.*

The Journal of Agriculture, and the Transactions of the Highland and Agricultural Society of Scotland, 1844, July and October. —*By the Society.*

Scheikundige Onderzoekingen, gedaan in het Laboratorium der Utrechtsche Hoogeschool. 2d Deel. 5d Stuk.—*By the Editors.*

Report of the Thirteenth Meeting of the British Association of the

Advancement of Science, held at Cork in August 1843.—*By the Association.*

The Eleventh Annual Report of the Royal Cornwall Polytechnic Society, 1843.—*By the Society.*

The Journal of the Royal Geographical Society of London. Vol. xiv., Part 1.—*By the Society.*

Proceedings of the Royal Astronomical Society. Vol. vi., Nos. 1–6. —*By the Society.*

The Electrical Magazine, conducted by Mr Charles V. Walker. Vol. i., No. 5.—*By the Editor.*

Journal of the Asiatic Society of Bengal. No. 143.—*By the Society.*

Journal of the Bombay Branch Royal Asiatic Society. Nos. 5 and 6. —*By the Society.*

Annales des Sciences Physiques et Naturelles, d'Agriculture et d'Industrie, publiées par la Société Royale d'Agriculture, &c., de Lyon. Tome vi.—*By the Society.*

Geologische Bemerkungen über die Gegend von Baden bei Rastadt. Von J. F. L. Hausmann.—*By the Author.*

Memoire sur le Daltonisme. Par Elie Wartmann.—*By the Author.*

Astronomische Nachrichten, herausgegeben, von H. C. Schumacher.—*By the Editor.*

Versuch einer objectiven Begrundung der Lehre von den drei Dimensionen des Raumes. Von Dr Bernard Bolzano.—*By the Author.*

Magnetische und Meteorologische Beobachtungen zu Prag. Von Karl Kreil—(vierter Jahrgang). *By the Author.*

Astronomical Observations made at the Royal Observatory, Greenwich, in the year 1842, under the direction of George Biddell Airy, Esq., M.A., Astronomer-Royal.—*By the Royal Society.*

Catalogue of the Places of 1439 Stars, referred to the 1st of January 1840; deduced from the Observations made at the Royal Observatory, Greenwich, from 1836, January 1, to 1841, December 31.—*By the Royal Society.*

Proceedings of the Geological Society of London. No. 98.—*By the Society.*

Memoires de la Société Geologique de France. (Deuxieme Serie). Tome i., Partie 1.—*By the Society.*

Sixth, Seventh, and Eighth Letters on Glaciers. By Professor Forbes.—*By the Author.*

Proceedings of the Zoological Society of London. Nos. 120 to 134.—*By the Society.*

Abhandlungen der Koniglichen Akademie der Wissenschaften zu Berlin—ans dem Jahre 1842.—*By the Academy.*

Bericht über die zur Bekantmachung geeigneten Verhandlungen der Konigl. Preuss. Akademie der Wissenschaften zu Berlin. Juli 1843 bis Juni 1844.—*By the Academy.*

Tijdschrift voor Natuurlijke Gescheidenis en Physiologie—Uitgegeven door J. van der Hoeven en W. H. De Vriese, M.D. Deel. xi. St. 2.—*By the Editors.*

Archief voor Geneeskunde—Uitgegeven door Dr J. P. Heije. Deel. iii, St. 4.—*By the Editor.*

Het Instituut of Verslagen en Mededeelingen, Uitgegeven door de vier Klassen van het koninklijk Nederlandsche Instituut van Wetenschappen, Letterkunde en Schoone Kùnsten over den Jare 1842, St. 4. 1843, St. 1, 2, 3.—*By the Royal Institute of Holland.*

Niewe Verhandelingen van het Bataafsch Genootschap, der Proefondervindelijke Wijsbegeerte te Rotterdam. Deel. ix., St. 1, 2, 3.—*By the Society.*

Memoire de l'Academie Imperiale des Sciences de Saint Petersbourg—(Sciences Politiques, &c.) Tome vi., Liv. 4, 5, 6. Tome vii., Liv. 1, 2, 3.

Ditto ditto, Sciences Mathematiques. Tome v., Liv. 4, 5, 6. Tome vi., Liv. 1.

Recueil des Actes de la Seance Publique de l'Academie Imperiale des Sciences de Saint Petersbourg, tenue le 29. Dec. 1843.—*By the Imperial Academy.*

Nouveaux Memoires de la Société Helvetique des Sciences Naturelles. Tomes i.–vi.—*By the Society.*

Actes de la Société Helvetique des Sciences Naturelles.—*By the Society.*

Verhandlungen der Schweirischen Naturforschenden Gesellschaft bei ihrer Versammlung zu Zurich, 1841.

Ditto ditto, zu Altdorf, 1842.—*By the Association.*

Specimens of Printing-Types in the Establishment of Neill & Co., Printers, Edinburgh.—*By Messrs Neill & Co.*

Comptes Rendus Hebdomadaires des Séances de l'Academie des Sciences. Tome xviii., Nos. 15–26, and Tome xix., Nos. 1–16.—*By the Academy.*

Maps of the Irish Ordnance Survey, containing the County of Limerick, 62 sheets.—*By the Lord Lieutenant.*

Monday, 16*th December* 1844.

SIR GEO. MACKENZIE, Bart., in the Chair.

The following Communications were read:—

1. On a Possible Explanation of the Adaptation of the Eye to Distinct Vision at Different Distances. By Professor Forbes.

The idea suggested in this paper, occurred to the author three years ago, from reflecting that the destruction of spherical aberration in the eye might be effected by a modification of the curvature of the lens, as well as by the variable density which it is known to possess, and which has usually been accounted for as intended for that purpose.

The author considering the probability to be almost infinite against the sphericity of the surfaces (a necessary evil in our instruments, but inexplicable in a natural organ), a conviction which he afterwards found to be reduced to certainty by experiments which have actually been made on the figure of the lens—he conceived that the variable density of this part of the eye must have some other cause. He considered it likely that it might contribute to the focal adjustment of the eye in the following way:—The lens is composed of coats more firm and tenacious, as well as more refractive, towards the centre, and less so at the sides. These coats are also nearly spherical in the centre, forming a nucleus of considerable resistance. Hence the author supposes, that if the lens be compressed in any manner by a uniform hydrostatic pressure, it will yield most readily in a plane at right angles to the axis of vision, and hence the lens will become more spheroidal, and, consequently, more refractive; that is, adapted for the vision of objects at small distances. The hydrostatic pressure in question is believed to be conveyed from the humours of the eye, between which the lens is delicately suspended, and to originate in the compressing action of the muscles which move the eye-ball acting simultaneously on the tough sclerotic coat.

The author thus sums up the evidence which he thinks gives probability to this explanation:—

1. The form of the surfaces of the lens might have been such as to correct aberration without any variation of density whatever. But, on the contrary, it has a form which exaggerates the ordinary spherical aberration. A form which, therefore, appears to be

adapted to the rapid variation of density in the lens, which must, therefore, be presumed to have some distinct mechanical utility.

2. The effort to view near objects is accompanied in most, if not all persons, by a sensible muscular effort.

3. This theory is free from the various conclusive objections urged by Dr Young against all explanations which do not turn upon a change of figure of the lens; and it is also free from the difficulties to the admission of Dr Young's theory,—the muscularity of the lens itself.

4. When the lens is reproduced, after the operation for cataract, the power of adjustment is greatly diminished or wholly lost, since the variable elasticity will be wanting.

5. The diminution of the adjusting power of the eye in old age is explained by the increased rigidity of the lens, and consequent incompressibility.

6. The crystalline lens polarizes light in a manner similar to that exerted by glass and other uncrystallized substances in a state of constraint, that is, possessing unequal elasticity in different directions.

2. Notice of an Ancient Beach near Stirling.
By Charles Maclaren, Esq.

This beach presents the appearance of a terrace, extending along the north side of the Carse of Stirling, from the foot of Abbey Craig westward to Lecropt Church, and beyond it. Its length is about two miles; its breadth, at Lecropt Church, is about 200 feet, at Airthrey Mineral Well 900 feet, and at Airthrey Castle near half a mile. Its upper surface is nearly a dead level in both directions, except where breaches have been made in it, by streams or other agents. The elevation of this surface above the Carse in about 85 feet, and above the Forth at Stirling probably 110 feet. Rock is seen under the terrace at the village of Causeyhead, in the bed of the River Allan, at the Bridge, and at the bottom of the acclivity under Lecropt Church. Everywhere else the terrace seems to consist of stratified sand and gravel, constituting a mass similar in form and materials to our present beaches. Its preservation may be attributed to the high rock of Abbey Craig, which protected it from the action of the ancient tides when the sea stood at a considerably higher level than it does at present. A remnant of a similar beach is seen on the south side of the Carse, about a mile southwest from Stirling. It consists of a hill of alluvial matter, a furlong south from Whitehouse Farm, and about 70 or 80 feet in height. A small portion of a lower terrace about 30 or 35 feet above the Carse, is found at the southwest foot of the rock of Stirling Castle; and a portion of a terrace of the same height is seen in connection with the higher terrace, extending for a short distance eastward of Lord Abercromby's south gate.

The following Donations were announced:—

Annuaire de l'Academie Royale des Sciences et Belles Lettres de Bruxelles, 1844.

Bulletin de l'Academie Royale de Bruxelles. Tome x., Nos. 8–12. Tome xi., Nos. 1–8.

Memoires Couronnés et Memoires des Savants Etrangers, publiés par l'Academie Royale des Sciences et Belles Lettres de Bruxelles. Tome xvi.

Annales de l'Observatoire Royale de Bruxelles, publiées par le Directeur, A. Quetelet. Tome iii.—*By the Academy.*

Annuaire de l'Observatoire Royale de Bruxelles, par A. Quetelet, Directeur de cet Etablissement, 1844.—*By the Author.*

Recherches Statistiques, par A. Quetelet.—*By the Author.*

Notices sur Pierre Simons, Alexis Bouvard, et Antoine Reinhard Falck, par A. Quetelet.—*By the Author.*

Bulletin de la Société Géologique de France. Tome i. Feuilles 28–33.—*By the Society.*

Novi Commentarii Academiæ Scientiarum Instituti Bononiensis. Vols. i., ii., iii., iv., v.—*By the Academy.*

Opere Edite et Inedite del Professore Luigi Galvani, raccolte e pubblicate per cura dell' Accademia delle Scienze dell' Institute di Bologna.—*By the Academy.*

On the Excision of the Eyeball in cases of Melanosis, Medullary Carcinoma, and Carcinoma, with Remarks by J. Argyll Robertson, M.D., F.R.S.E.—*By the Author.*

Monday, 6th January 1845.

Sir T. M. BRISBANE, Bart., President, in the Chair.

The following Communications were read:—

1. Farther Remarks on the Electrical Organs of the Rays. By Dr Stark.

2. Observations on the same subject. By John Goodsir, Esq.

3. Note on the Form of the Crystalline Lens. By Professor Forbes. Included in the former Abstract.

4. On the Cause which has produced the Present Form and Condition of the Earth's Surface. By Sir George Mackenzie, Bart.

The author first described, generally, the appearance of the loose materials covering the surface; and referred to some districts in the north of Scotland, especially the central one on the borders of Perth and Inverness shires, as demonstrating the effects of vast currents of water having passed over the surface. He also referred to the valleys of the river Conan and its tributaries, in Ross-shire, as presenting an epitome of all the phenomena which may be supposed to result from a vast flood gradually subsiding, and taking the direction of the valleys. He then shortly alluded to the theories proposed to account for the present condition of the surface, which appear to resolve themselves into the effects of a remote cause.

It being generally admitted that the crust of the earth now appears broken, some portions having been elevated, and some having sunk ; and that this breaking up of the strata, causing them to take various positions, the broken portions being inclined at different angles, some being vertical; and that this dislocation of the strata is observed everywhere ; it is obvious that a tremendous force must have been exerted to produce these effects. The elevation of the former ocean bottom, and the sinking of much of the former land, would occasion an agitation of the waters such as would have caused the waves to overtop the mountains; and as the waves subsided currents would have been directed with great violence through all the valleys, sufficient to produce all the phenomena we observe, except those which may be fairly attributed to a subsequent gradual rising of the land, and to partial convulsions.

Sir George concluded by observing that, probably, Man had not appeared on the earth previous to the great convulsion by which the order of the strata had been so greatly disturbed ; for, besides no human fossil remains having yet been found, man, without such disturbance of the rocks, could not have enjoyed what external nature offers to his senses, nor have discovered the minerals and organic remains which have contributed so much to his wealth and comfort, as well as to the noblest exercise of his mental faculties.

The following Candidates were duly elected Fellows of the Society:—

Dr James Andrew, F.R.C.P.
Dr Geo. Wilson, Lecturer on Chemistry.

The following Donations were announced:—

The Journal of Agriculture, and the Transactions of the Highland and Agricultural Society of Scotland, for January 1845.—*By the Society.*

Arsberättelse om Zoologiens Framsteg under ären 1840–42. Af S. Loven.

Arsberättelse om Framstegen i Kemi och Mineralogafgiven, den 31 Mars 1844. Af Jac. Berzelius.

Arsberättelse om Botaniska Arbeten och Upptackter for är 1838. Af J. E. Wikstrom.

Kongl. Vetenskaps-Academiens Handlingar, for är 1842.

Ofversight af Kongl. Vetenskaps-Academiens Forhandlingar, 1844. Nos. 1 to 7.—*By the Academy.*

The Journal of the Royal Asiatic Society. No. 15, Parts 1, 2.—*By the Society.*

Observations Meteorologiques faites à Nijne-Taguilsh (Monts Oural) Government de Perm. Annee 1842.

Mittlere Oerter von 12,000 Fix-Sternen, von Carl Rumker. Part 1, containing pp. 1–47.—*By Sir Thomas Brisbane.*

Monday, 20*th January* 1845.

The Right Reverend Bishop TERROT, V. P., in the Chair.

The following Communications were read:—

1. Some Account of the Magnetic Observatory at Makerstoun, and of the Observations made there. By J. A. Broun, Esq. Communicated by Sir T. M. Brisbane, Bart.

The observatory is situated on a rising ground forming the left bank of the Tweed, and is at a distance of about fifty yards from the Astronomical Observatory. It is built of wood; copper nails were used, and all iron carefully excluded from the building.

The plan of the observatory is rectangular, 40 feet long by 20 broad: it is divided into one large room to the north, 40 feet by 12, and two ante-rooms to the south, with the lobby and entrance doors between.

The magnetometers and telescopes in the observatory are placed on stone pillars of about 20 inches diameter, having good foundations, and being completely disconnected with the floor, so that no tremor can be communicated to the instruments by walking past them.

The instruments in the observatory are of two classes, Magnetical and Meteorological.

Belonging to the former class, there are, 1. The Declination Magnetometer, used for determining the variations and absolute values of the angle formed by the astronomical and magnetic meridians. 2. The Bifilar Magnetometer, by means of which the variations of the horizontal component of the earth's magnetic force are obtained. 3. The Balance Magnetometer, which gives the variations of the vertical component. 4. The Inclinometer, used for obtaining the magnetic dip, or the angle formed by the direction of the earth's total intensity, and a horizontal plane, namely, in the magnetic meridian. 5. An extra Declinometer in a small wooden building, at a distance from the observatory, is used for obtaining the *absolute* value of the horizontal component of the earth's magnetic force, according to the method of Gauss.

The second class of instruments is the Meteorological.

These are,—1, The Barometer, a standard by Newman, similar to that belonging to the Royal Society. The tube is 0·552 inches in diameter.

2. Thermometers. The dry and wet bulb thermometers, by Messrs Adie and Son, are placed on a revolving wooden frame opposite one of the north windows. They are always read from within the observatory, the frame being moved by means of cords and pullies. Maximum and minimum register thermometers, by Adie and Son, are placed on the north side of the observatory. Self-registering black bulb thermometers, for solar and terrestrial radiation, are placed in an enclosed space at a distance from the observatory.

3. Anemoscope and Anemometer.

4. The Rain-Gauge.

In 1841 and 1842, daily observations were made at the Göttingen hours of 8 and 11 A.M., and 2 and 5 P.M.; in 1843 at 6, 8, 10, A.M.; Noon; 2, 4, 6, 8, and 10, P.M. Another observation was made at 11 A.M., after October 1843; in 1844, at every hour of the twenty-four; and this system is being continued in 1845.

The instruments observed at these hours were, the declination, the horizontal force, and vertical force, magnetometers,—the barometer, its height and temperature,—the dry and wet bulb external thermometers, and the thermometers of the two force magnetometers. To these were added observations of the weather.

The magnetic inclination, or dip, has been observed since the commencement, with a few exceptions, twice a-week.

Since July 1841, the monthly periods, named Terms, have been regularly kept. The terms are periods of twenty-four hours, which occur once a-month, on days previously agreed upon, and during which simultaneous observations of the magnetometers are made in all the magnetic observatories. At present, the three magnetometers are observed every five minutes of the 24 hours, meteorological observations being made hourly. In this way, each term produces 388 observations of each magnetometer, comparable with the observations made at the same instant in the other observatories.

Finally, observations for the absolute declination and absolute horizontal intensity of the earth's magnetism have been made as regularly as possible at different periods of the year.

The second class of observations is irregular, and comprise all those observations of phenomena which are irregular in their periods. The most important of this class are the extra magnetic observations. Whenever the magnets are found to have assumed positions differing unusually from those at the previous observations, they are watched, and if found to be moving, extra observations are immediately commenced. When the disturbance is moderate, the three instruments are observed every five minutes, as on term days; if it be considerable, an instrument is observed every minute.

Much attention has been paid to the magnetic disturbances in 1844. Upwards of 60,000 extra-readings of the magnetometers having been made in that year, giving about 25,000 mean positions.

The aurora borealis is as carefully observed as due attention to the magnetic disturbance with which it has here been found invariably accompanied, will allow. Attention is paid to the measurement and description of halos, parhelia, and paraselenæ.

The reductions are at present in a considerable state of forwardness; and it is expected that the volume for 1843 will be ready to place in the printer's hands as soon as that for 1841 and 1842 is issued.

2. Description of a Sliding Scale for Facilitating the Use of the Moist-bulb Hygrometer. By James Dalmahoy, Esq.

The instrument described in the paper is made of German silver, and is about a foot in length, and $\frac{3}{10}$ of an inch in breadth; along the middle of it there is a groove for a slider. On the right edge of the groove is engraved a scale of inches, and on the left the degrees of temperature from 0° to 85° Fahrenheit, each being placed exactly opposite that point of the scale of inches which measures the corresponding tension of vapour. On the left edge of the slider is engraved a scale of equal parts, each $\frac{10}{87}$ of an inch; on the right edge, and having the same zero, is a vernier, applicable to the scale of inches. The lines on these scales are ten times larger than those which the symbols in the dew-point formula represent, but their numerical designations are not changed.

The instrument is to be used as follows:—Find on the slider the number which expresses the difference between the indications of the dry and moist bulb thermometers, and bring it opposite the number on the left scale, denoting the temperature of the moist-bulb; then zero on the slider will indicate, on the left scale, the temperature of the dew-point; and on the right scale, the corresponding force of vapour.

The paper concludes by shewing that the ordinary hygrometric formula, which suggested the idea of the sliding scale, indicates also a geometrical construction for finding the temperature and tension of vapour at the dew-point, which, however, would not be practically applied with convenience.

3. Account of Experiments to Measure the Direct Force of the Waves of the Atlantic and German Oceans. By Thomas Stevenson. Communicated by David Stevenson, Esq.

The author has attempted to supply a great desideratum in the practice of marine engineering, by instituting a series of experiments to ascertain what force the waves exert against opposing barriers.

For this purpose he suggests, in some peculiar situations, the use of columns of water or of air, by which the force of each wave can be ascertained; in the one case by the rise of the water-column, or in the other by a pressure-gauge, shewing the same result in atmospheres by compression. But in all the observations as yet made he has used an instrument which may be termed a "*self-registering*

Marine Dynamometer." This dynamometer is contained in an iron cylinder, which is fixed to the rock where the experiments are to be made. The instrument consists of a plate or disc attached to a powerful spring, which is lengthened by the action of the waves. In graduating the instrument, the pressure required to lengthen the spring, a given quantity is ascertained by loading the disc with weights, so that when the quantity that the spring has yielded by the action of the sea is known, the pressure due to the area exposed is known also. The discs employed varied from 3 to 9 inches in diameter, and the resistance of the springs from about 10 lb. to about 50 lb. for every ⅛ inch of elongation. With a view to check the results, three instruments, of very different powers of springs, were besides placed each other on an exposed rock, for a space of about six months, and the results were found to be remarkably concordant As the action of a wave may be supposed to combine the effects of a sudden impact with a subsequent continuous pressure, an objection might be urged against estimating these effects statically; and the author has accordingly made some remarks relative to this subject, which it is not, however, necessary here to state.

The results obtained are, up to this date, 260 in number, and these embrace a continuous register of the agitations of the Atlantic (as ascertained at the Skerryvore Rocks, Argyllshire,) for the last 22 months; together with a later train of similar observations, on the German Ocean, made at the Bell Rock Lighthouse. The following is a digest of the results obtained:—

Atlantic Ocean.

Average of results for 5 *summer* months, during the years 1843 and 1844, is 611 lb. per square foot.

Average of results for 6 *winter* months during the same years is 2086 lb. per square foot, or thrice as great as in the summer months.

Greatest result yet obtained at Skerryvore, being on the 20th December 1844, is 4335 lb. per square foot.

German Ocean.

Greatest result yet obtained at the Bell Rock, being on the 9th October 1844, is 3013 lb. per square foot.

The greatest effect of the sea, which has been observed, is, therefore, that of the Atlantic, which is *equal to about* 2 *tons per square foot*.

There are also a few observations (made in April and June 1842) upon the Irish Sea, on the coast of Kirkcudbright, but the weather was unfavourable for such observations; the highest result was 840 lb. on a square foot. The communication concludes with an account of several instances of the effects of the waves in the elevation of spray, and in the transportation of heavy masses of rock. The greatest observed elevation of spray was at the Bell Rock Lighthouse, on the 20th November 1827, during a calm with a ground swell. On this occasion the spray was projected to the height of 106 feet, which shews the existence, on the large scale, of a pressure of about 3 tons. The pressure which projected this column of spray exceeds, therefore, the greatest result obtained by the Marine Dynamometer. The largest stone that is mentioned in the paper, as having been moved by the sea, is 42 tons weight. This stone, which is on the shores of one of the Hebrides, *was seen* to move under the influence of each wave.

4. A Verbal Communication in regard to Chevalier's Experiments on the Decomposition of certain Salts of Lead by Charcoal. By Dr Traill.

The following Donations were announced:—

Journal of the Royal Asiatic Society of Bengal. Nos. 144, 145.—*By the Society.*

On the Nature of the Nervous Agency. By James Stark, M.D., F.R.S.E.—*By the Author.*

Researches on the Brain, Spinal Cord, and Ganglia, with Remarks on the Mode by which a continued flow of Nervous Agency is excited in, and transmitted from, these organs. By James Stark, M.D., F.R.S.E.—*By the Author.*

Philosophical Transactions of the Royal Society of London for 1844. Part ii.

Proceedings of the Royal Society of London. No. 59.—*By the Royal Society.*

Magnetical and Meteorological Observations made at the Royal Observatory, Greenwich, in the year 1842, under the direction of George Biddell Airy, Esq., M.A., Astronomer-Royal. —*By the Royal Society.*

Outlines of Chemistry for the use of Students. By William Gregory, M.D., Professor of Chemistry in the University of Edinburgh.—*By the Author.*

Monday, 3d *February* 1845.

Sir T. M. BRISBANE, Bart., President, in the Chair.

The following Communications were read :—

1. On a Peculiar Modification of the Doubly Refracting Structure of Topaz. By Sir D. Brewster, K.H.

While examining, in polarised light, some of the crystals which he had discovered in Topaz, the author observed certain optical phenomena, depending on a peculiarity of structure. This peculiarity is manifested either in the depolarisation of light, when it gives rise to four quadrants of light, separated by the radii of a black rectangular cross similar to the central portion, or the tints of the first order in the uniaxal system of polarised rings, or in the unequal refraction of common light, which gives rise to the mirage of a luminous point, in the form of concentric circles surrounding the centre of force. In every case there was found a quadrangular cavity in the centre of the intersection of the cross, generally dark and opaque, but in one case having a luminous spot in the centre. These cavities are from the $\frac{1}{3000}$ to the $\frac{1}{4000}$ of an inch in diameter.

These cavities are quite distinct from all those formerly described by the author ; and from the phenomena above described, he concludes that the contents of each cavity have exerted an elastic force on the surrounding mineral while in a plastic state. In some cases fissures are seen proceeding from the central cavities, but these are supposed to have been produced after the mineral had become indurated, and had already been subjected, in the plastic state, to the pressure or force above indicated.

These cavities never accompany the cavities with two fluids, but occur in specimens containing numerous embedded crystals, differing little from Topaz in refracting power.

Since the mineral must have been plastic when it yielded to the pressure here noticed, it cannot have been formed by the aggregation of molecules having the primary form of the crystal.

These considerations, along with others connected with the crystals, which occur in the cavities of Topaz, have led the author to adopt the idea of a new and peculiar kind of crystallization, to which he will soon direct attention.

2. Extracts from Letters to the General Secretary, on the Analogy of the Structure of some Volcanic Rocks with that of Glaciers. By C. Darwin, Esq., F.R.S. Specimens were exhibited. With Observations on the same subject, made by Professor Forbes.

"I take the liberty of addressing you, knowing how much you are interested on the subject of your discovery of the veined structure of glacier ice. I have a specimen (from Mr Stokes's collection) of Mexican obsidian, which, judging from your description, must resemble, to a considerable degree, the zoned ice. It is zoned with quite straight parallel lines, like an agate; and these zones, as far as I can see under the microscope, appear entirely due to the greater or lesser number of excessively minute, flattened air cavities. I cannot avoid suspecting that in this case, and in many others, in which lava of the trachytic series (generally of very imperfect fluidity) are laminated, that the structure is due to the stretching of the mass or stream during its movement, as in the ice-streams of glaciers. * * *

"If the subject of the lamination of *volcanic* rocks should interest you, I would venture to ask you to refer to p. 65–72 of my small volume of 'Geological Observations on Volcanic Islands.'* I there throw out the idea, that the structure in question may perhaps be explained by your views on the zoned structure of glacier ice, the layers of less tension being, in the case of the Ascension obsidian-rocks, rendered apparent, chiefly by the crystalline and concretionary action superinduced in them, instead of, as in zoned ice, by the congelation of water. * * *

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* The laminated, volcanic rocks of Ascension, consist, as described by Mr Darwin, of excessively thin, quite parallel layers of minute crystals of quartz (determined by Professor Miller) and diopside; of atoms of an oxide of iron, and of an amorphous, black angitic mineral; and, lastly, of a more or less pure feldspathic stone, with perfect crystals of feldspar placed lengthways. The following is a portion of the passage referred to:—"Several causes appear capable of producing zones of different tension in masses semiliquified by heat. In a fragment of devitrified glass I have observed layers of sphærulites, which appeared, from the manner in which they were abruptly bent, to have been produced by the simple contraction of the mass in the vessel, in which it cooled. In certain dykes on Mount Ætna, described by M. Elie de Beaumont, as bordered by alternating bands of scoriaceous and compact rock, one is led to suppose that the stretching movement of the surrounding strata, which originally produced the fissures, continued, whilst the injected rock remained fluid. Guided, however, by Professor Forbes's clear description of the zoned structure of glacier ice, far the most probable explanation of the laminated structure of these feldspathic rocks appears to be, that they have been stretched, whilst slowly flowing onwards in a pasty condition, in precisely the same manner, as Professor Forbes believes, that the ice of moving glaciers is stretched and fissured. In both cases, the zones may be compared to those in the finest agates; in both, they extend in the direction in which the mass has flowed, and those exposed on the surface are generally vertical. In the ice, the porous laminæ are rendered

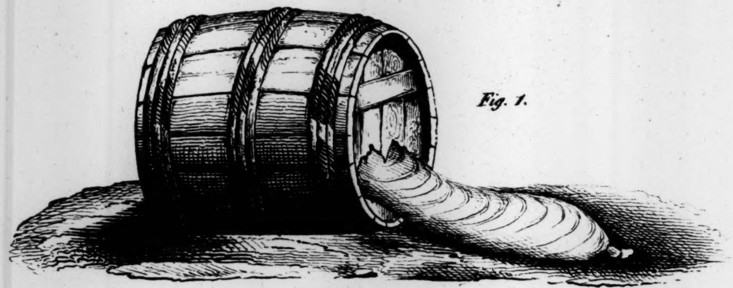
"How singular it at first appears, that your discoveries in the structure of glacier ice should explain the structure, as I fully believe they will, of many volcanic masses. I, for one, have for years been quite confounded whenever I thought of the lamination of rocks which have flowed in a liquified state. Will your views throw any light on the primary laminated rocks ? The laminæ certainly seem very generally parallel to the lines of disturbance and movement. Believe me, &c. C. Darwin."

To Professor Forbes.

Professor Forbes confirmed the previous remarks by others, made by himself on the specimens transmitted to him by Mr Darwin, and on specimens from Lipari and Iceland in the collection of the Royal Society, as well as by direct observations made by himself on the lava streams of Ætna.

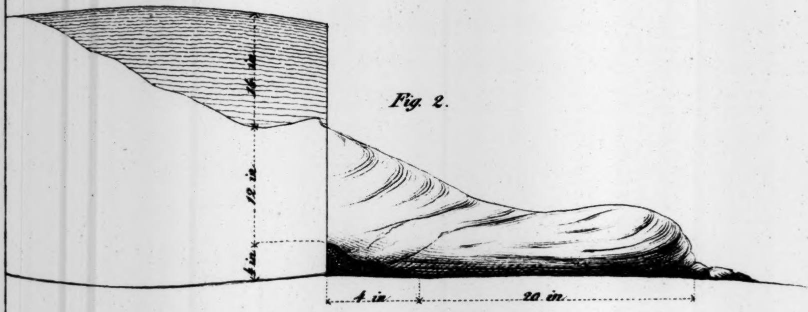
distinct by the subsequent congelation of infiltrated water; in the stony feldspathic lavas by subsequent crystalline and concretionary action. The fragment of glassy obsidian in Mr Stokes's collection, which is zoned with minute air-cells, must strikingly resemble, judging from Professor Forbes's description, a fragment of the zoned ice; and if the rates of cooling and the nature of the mass had been favourable to its crystallization, or to concretionary action, we should here have had the finest parallel zones of different composition and texture. In glaciers, the lines of porous ice and of minute crevices seem to be due to an incipient stretching, caused by the central parts of the frozen stream moving faster than the sides and bottom, which are retarded by friction. Hence, in glaciers of certain form, and towards the lower end of most glaciers, the zones become horizontal. May we venture to suppose that, in the feldspathic lavas with horizontal laminæ, we see an analogous case? All geologists who have examined trachytic regions have come to the conclusion, that the lavas of this series have possessed an exceedingly imperfect fluidity; and as it is evident that only matter thus characterized would be subject to become fissured, and to be formed into zones of different tensions, in the manner here supposed, we probably see the reason why augitic lavas, which appear, generally, to have possessed a higher degree of fluidity, are not, like the feldspathic lavas, divided into laminæ of different composition and texture. Moreover, in the augitic series, there never appears to be any tendency to that kind of concretionary action, which, we have seen, plays an important part in the lamination of rocks of the trachytic series, or, at least, in rendering that structure apparent."

Fig. 1.



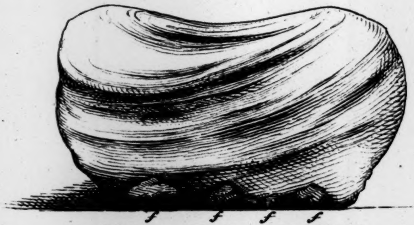
General View of the Brocken Headed Barrel of Stockholm Pitch.

Fig. 2.



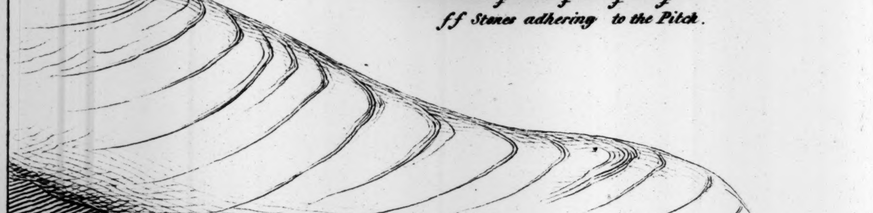
Elevation.

Fig. 4.



ff Stones adhering to the Pitch.

Fig. 3.



Enlarged View of the Pitch as observed.

Stones Carried along by the Stream or rather pushed

Fr. Schenck Lith. Edinr.

3. Professor Forbes then read the following Letter from Professor Gordon, of Glasgow, also on the subject of the Viscous Theory of Glaciers.

GLASGOW, *January* 31. 1845.

* * * When you requested me to give you a memorandum of what appeared to me to be the *very glacier-like motion* and appearance of Stockholm pitch flowing from a barrel, I considered my observation to have been too casual to be worth writing, and having foreseen that I could arrange an experiment at Gateshead in the beginning of the year, I delayed giving you the memorandum you wished. I had hoped to have been able to inspect and report on my experiment about this time; but I cannot go to Gateshead for some time to come, nor have I had any report of the progress of my pitch glacier since the 6th January, when I was informed it had not moved since the day after I left it, on the 28th December. Your note of yesterday induces me to offer you the following still perfectly vivid impressions of the analogy between *ice* and *Stockholm pitch.*

Allow me, in the first place, to mention that I read your travels in the Alps, in May last. That on the 24th of June I spent almost 20 hours on the glaciers of the Grindewald. I went up by the lower glacier, prepared with poles to prove the motion, and actually observed a progress of about 12 inches in the course of 13 hours, from 6 A.M. to 7 P.M. I traced the "dirt bands" on the surface. I was let down into several crevasses, one of them to a depth of 30 feet and could trace the *slaty structure* of the ice. The alternate clear blue thin veins, and the transition to opaque grey or even white. I descended from the glacier with a much better appreciation of the theory of glaciers than I had had, and a strong conviction that the facts I had observed, could not be otherwise accounted for than by the mechanical theory you have given. In passing through Gateshead in August, a broken headed barrel of Stockholm pitch at the Wire Rope Factory, attracted my attention. Its general appearance is represented in Fig. 1.

A mass of Stockholm pitch *broken* from a barrel in August (at the time of the observations I am about to mention) presented a dark-brown colour, a glassy lustre, translucent edges. The substance is fragile, fracture conchoidal, and very uniform. A mass, Fig. 4., which was brought to me by the workman having charge of this department, and which he had broken from the end of such a *stream* as I have represented coming from the barrel, presented generally the same appearance as a mass broken from an entire